LEPTOGENESIS

AND

SUPERSYMMETRY

Y. Yanagida

SUSY02

at DESY

NEUTRINOS HAVE SMALL MASSES !!

ATMOSPHERIC ν OSCILLATION :

Super K

$$\sqrt{\Delta m^2_{\nu_{3,2}}} \simeq 0.05 \text{ eV}$$

SOLAR ν OSCILLATION :

Super K
SNO
⋮

$$\sqrt{\Delta m^2_{\nu_{2,1}}} \simeq (0.3-1) \times 10^{-2} \text{ eV}$$

IN THE STANDARD THEORY :

$$\mathcal{L} = \frac{1}{M} \, l \cdot l \, H \cdot H$$

$l = \begin{pmatrix} \nu \\ e \end{pmatrix}$

$\langle H \rangle \simeq 250$ GeV

$$M \simeq 10^{15} - 10^{16} \text{ GeV}$$

NEW SCALE !

$\neq G_F^{-1/2}$; Planck

THE FIRST EVIDENCE.

⊕ SUSY

I. LEPTOGENESIS VIA FLAT DIRECTIONS

SUSY THEORY HAS MANY FLAT DIRECTIONS ϕ

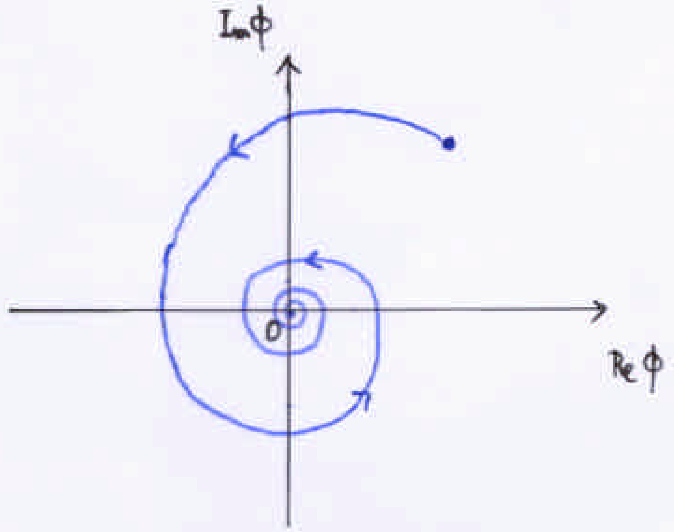
CONSIST OF SQUARKS, SLEPTONS AND HIGGS.

THEY MAY HAVE LARGE CLASSICAL VALUE DURING INFLATION AND START OSCILLATING WHEN $H \sim m_\phi$.

IF $\not{B}$ OR $\not{L}$ OPERATOR EXISTS, PHASE ROTATION OCCURS WHEN ϕ STARTS THE OSCILLATION, PRODUCING B OR L NUMBER.

$$B, L \sim \frac{-i}{2}\left\{\phi^* \dot{\phi} - \dot{\phi}^* \phi\right\}.$$

Affleck, Dine (1985) {B-PRODUCTION



B OR L PRODUCTION

NOW, WE KNOW THE PRESENCE OF $\cancel{L}$ OPERATOR:

$$W = \frac{1}{M}(LH)(LH)$$

↳ NEUTRINO MASS

L-NUMBER PRODUCTION IS POSSIBLE BY TAKING A FLAT DIRECTION:

$$\tilde{L} = \frac{1}{\sqrt{2}}\begin{pmatrix}\phi \\ 0\end{pmatrix}, \quad H = \frac{1}{\sqrt{2}}\begin{pmatrix}0 \\ \phi\end{pmatrix}.$$

Murayama, T.Y. (1994)

⊙ $\cancel{\text{SUSY}}$ INDUCES

$$V(\phi) = a\frac{m_{3/2}}{8M}\phi^4 + \text{h.c.},$$

WHICH GIVES THE PHASE ROTATION OF ϕ.

※ INITIAL VALUE OF ϕ_0:

DURIN INFLATION ϕ MAY HAVE $\cancel{\text{SUSY}}$ SOFT MASS OF ORDER OF H_{inf}. IF $m_{eff}^2 > 0$, ϕ MOVES TO THE ORIGIN $\phi = 0$ AND LEPTOGENESIS DOES NOT OCCUR. BUT, IF $m_{eff}^2 < 0$, ϕ MOVES TO INFINITY AND STOPS DOWN AT

$$|\phi_0| \simeq \sqrt{H_{inf} M}.$$

Dine, Randall, Thomas (1996)

* THERMAL EFFECTS HAVE TO BE TAKEN INTO ACCOUNT IF $|\phi_0| \ll M_{\rm planck}$.

$W = Y_u H \bar{u} Q \qquad m_u = \underset{10^{-5}}{Y_u}\phi < T$

$m_\phi^2(\text{thermal}) \simeq Y_u^2 T^2 > H^2_{\,\,u_{\,\,m_{3/2}}}$

EARLY OSCILLATION TAKES PLACE. D.R.T.

Allahverdi, Campbell, Ellis

Anisimov, Dine

→ DETAILED ANALYSES WERE GIVEN BY

Asaka, Fujii, Hamaguchi.

n_L IS VERY INSENSITIVE TO THE REHEATING TEMPERATURE T_R IN THE RANGE $T_R \simeq 10^5 - 10^{12}$ GeV.

$H_{\rm inf} \uparrow \quad |\phi_0| \uparrow \quad n_L \uparrow$

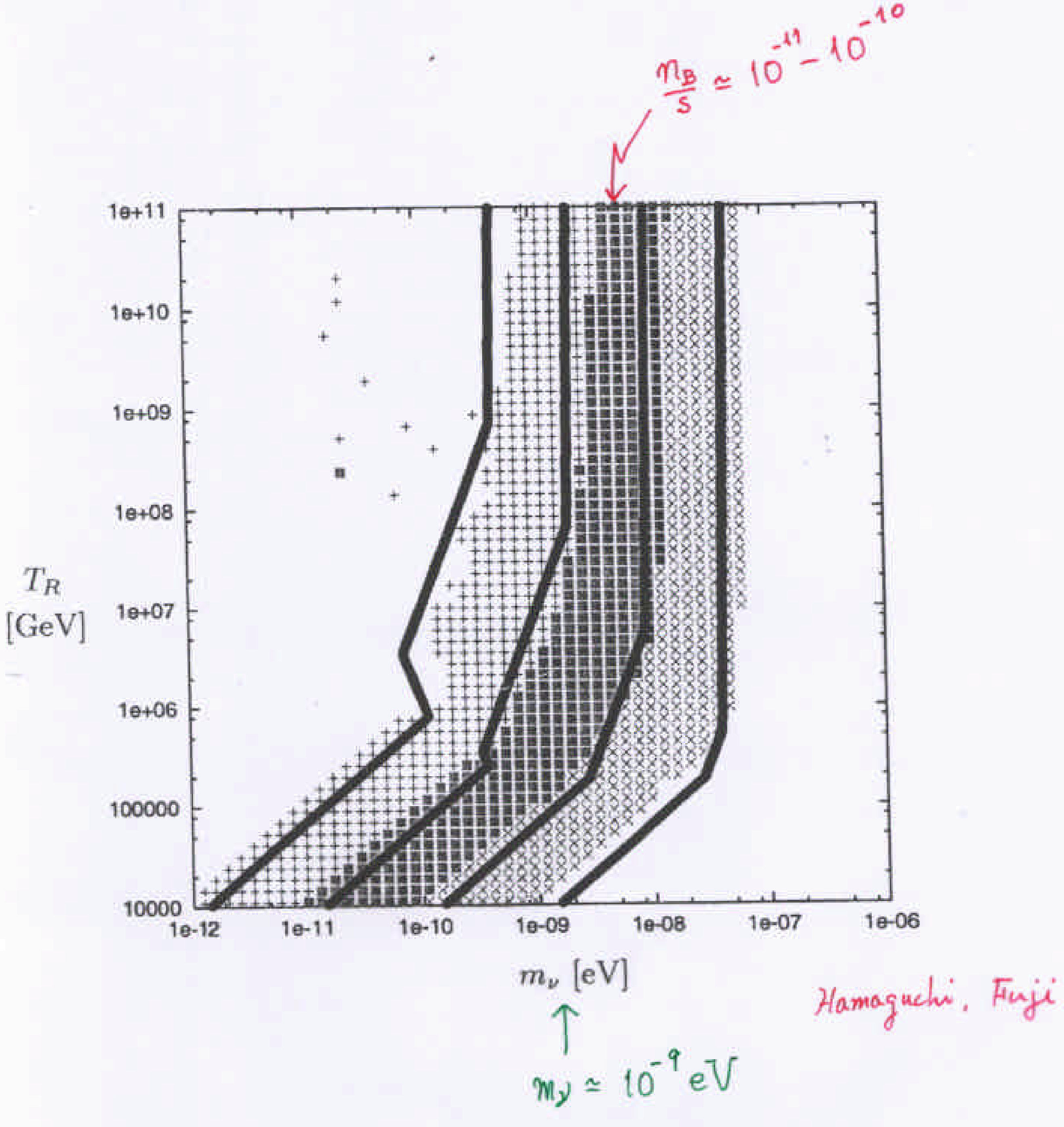
BUT $\quad T \uparrow \quad$ early oscillation. $\quad n_L \searrow$

* L-ASYMMETRY IS CONVERTED TO B-ASYMMETRY IN THE UNIVERSE THROUGH THE SPHALERON EFFECTS.

Kuzumin, Rubakov, Shaposhnikov (1985) ; Fukugita, T.Y. (1986)

$$\frac{n_B}{s} \simeq (-0.35) \times \frac{n_L}{s}$$

$$\simeq 10^{-10}\, \delta_{\rm eff} \left(\frac{m_\nu}{10^{-9}\,{\rm eV}}\right)^{-1/2} \left(\frac{m_{3/2}}{1\,{\rm TeV}}\right).$$



$\frac{n_B}{s} \simeq 10^{-11} - 10^{-10}$
1e+11
1e+10
1e+09
1e+08
1e+07
1e+06
100000
10000
T_R [GeV]
1e-12
1e-11
1e-10
1e-09
1e-08
1e-07
1e-06
m_ν [eV]
$m_\nu \simeq 10^{-9}$ eV
Hamaguchi, Fuji

Fig. 1

THE BARYON ASYMMETRY IN THE PRESENT UNIVERSE

$$\frac{n_B}{s} \simeq (0.4-1) \times 10^{-10}$$

SUGGESTS

$$m_\nu \simeq (0.1-3) \times 10^{-9}\, \mathrm{eV}.$$

SEE Fig.

DIFFICULT TO TEST THIS.

BUT, $m_{\nu_1} \ll m_{\nu_{2,3}}$,

CAN BE TESTED, SINCE THIS LARGE HIERARCHY PREDICTS $0\nu 2\beta$ DECAY AS

$$\langle m_{\nu_e \nu_e} \rangle \simeq (0.5-3) \times 10^{-3}\, \mathrm{eV}$$

FOR THE NORMAL MASS HIERARCHY.

$$\langle m_{\nu_e \nu_e} \rangle \simeq (2-5) \times 10^{-2}\, \mathrm{eV}$$

FOR THE INVERTED MASS HIERARCHY.

Vissani

Fuji, Hasenguchi

SEE Figs.

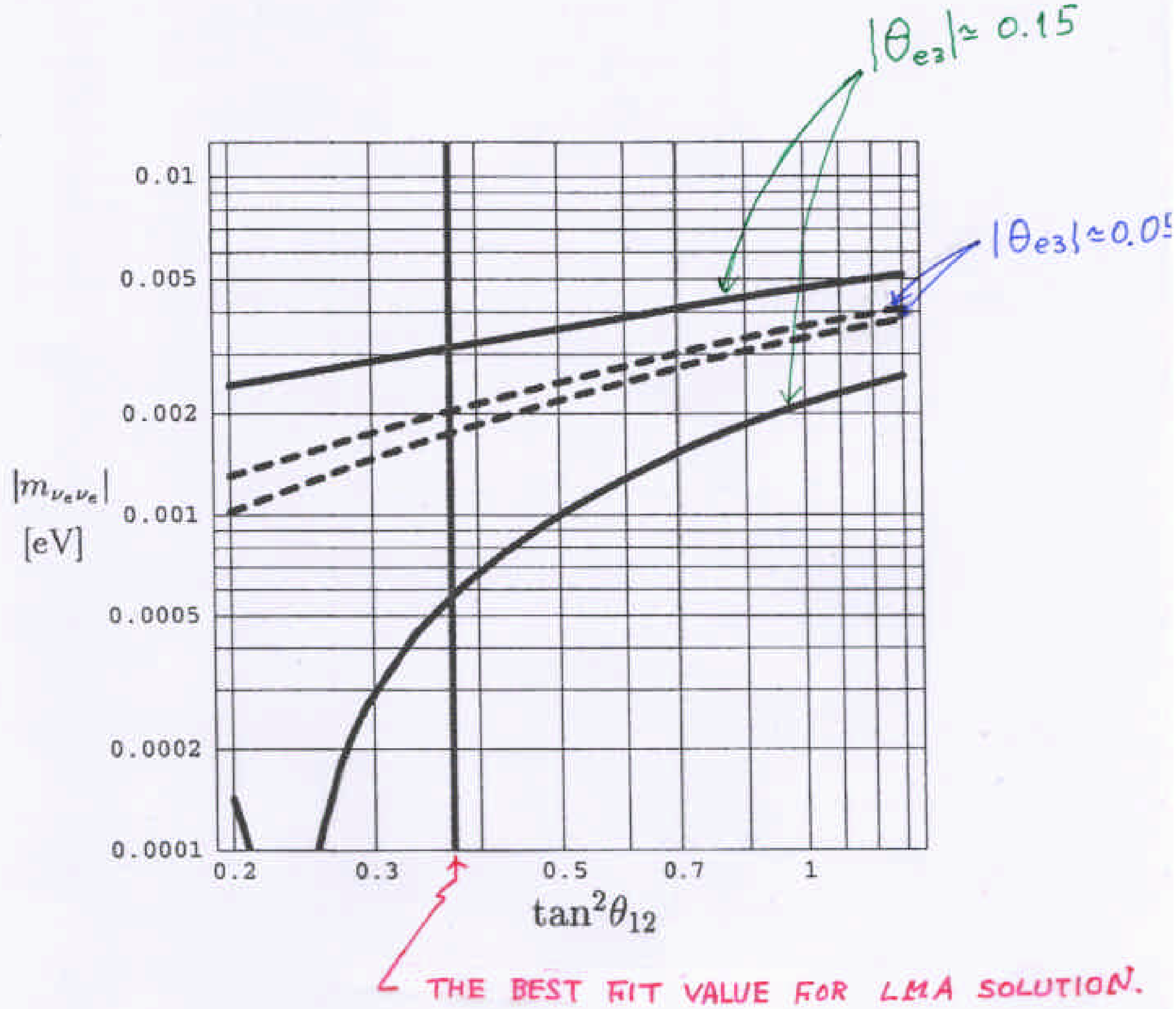
$$\begin{pmatrix} a & b \\ b & c \end{pmatrix}$$

LARGE MIXING $\rightarrow$ $b \sim |c-a|$

$m_{\nu_1} \ll m_{\nu_2}$ $\rightarrow$ $\det M \simeq 0$

$\hookrightarrow$ $a \sim c \sim b \quad (a \neq 0)$

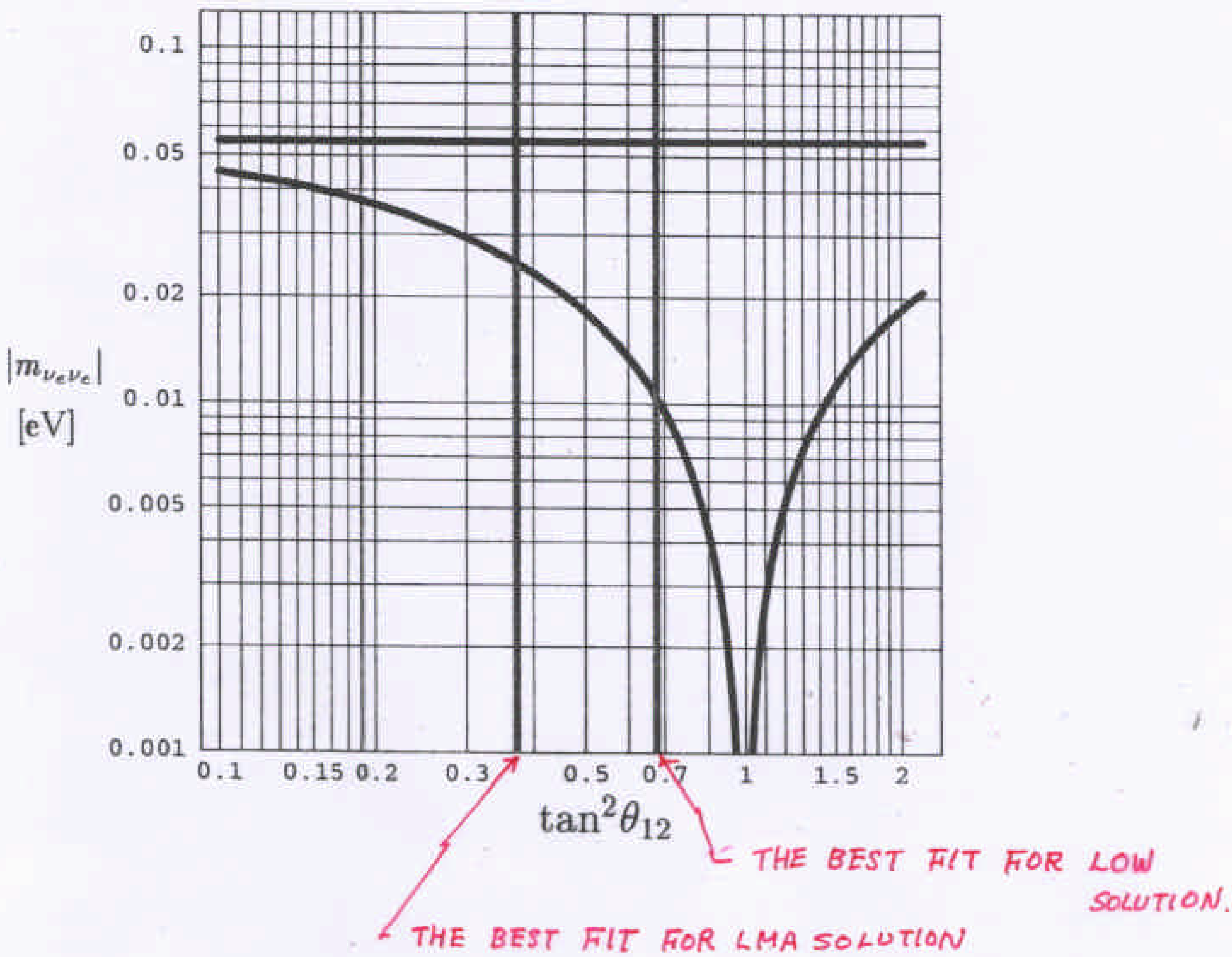
NORMAL MASS HIERARCHY , $m_{\nu_3} > m_{\nu_2} > m_{\nu_1}$.



$$< m_{\nu_e\nu_e} > \simeq 5\times10^{-4} - 3\times10^{-3}\ \mathrm{eV}$$

Fig. 2

INVERTED MASS HIERARCHY, $m_{\nu_2} > m_{\nu_1} > m_{\nu_3}$.



$$m_{\nu_e\nu_e} \simeq (2-5)\times 10^{-2}\,\mathrm{eV} \quad \text{FOR LMA.}$$

$$\simeq (1-5)\times 10^{-2}\,\mathrm{eV} \quad \text{FOR LOW.}$$

Fig. 3

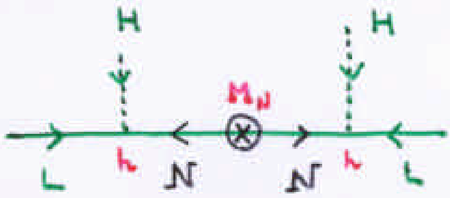
II. LEPTOGENESIS VIA N DECAY

THE MOST NATURAL MODEL INDUCING THE EFFECTIVE OPERATOR, $\frac{1}{M}(LH)(LH)$, IS GIVEN BY

THE SEESAW MECHANISM OF GRSY.

Gell-Mann, Ramond, Slansky, Yanagida (1979)

THIS ASSUMES SUPER-HEAVY MAJORANA FERMIONS N.



$$W = \frac{h^2}{M_N}(LH)(LH)$$

$$M \equiv \frac{M_N}{h^2}$$

$$M_N \simeq 10^{12} - 10^{15}\ \mathrm{GeV}$$

FOR $h \simeq 0.03 - 1$

- N IS A KEY POINT FOR UNIFICATION.

→ MANY APPLICATIONS WERE PROPOSED AFTE THE GRSY.

F. Wilzcek (1979) SO(1

S. Weinberg (1979) Genera

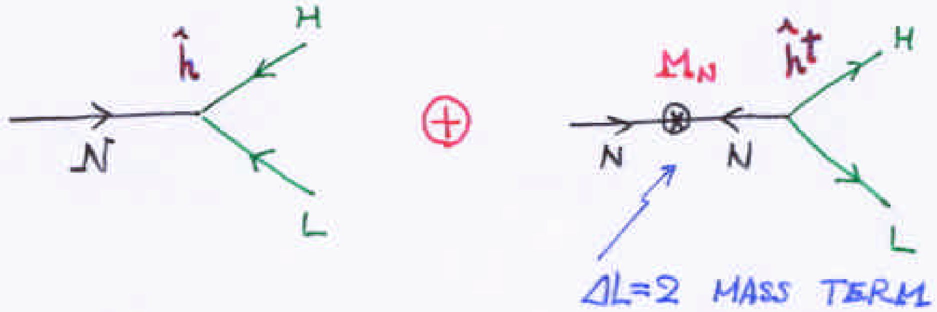
E. Witten (1980) SO(10)

Mohaptra, Senjanovic (1980) L-R sym

⋮

N's MAY BE PRODUCED IN THE EARLY UNIVERSE IF $T_R \gtrsim M_N$.

N DECAY HAS LEPTON-NUMBER VIOLATION.



IF THE Yukawa COUPLING CONSTANTS $\hat{h}_{ij}$ HAVE $\cancel{CP}$ PHASES, N DECAY PRODUCES LEPTON ASYMMETRY:

$$BR(N \to \bar{L} + \bar{H}) \neq BR(N \to L + H).$$

PRODUCED L ASYMMETRY $\underset{\text{CONVERTED}}{\longmapsto}$ B ASYMMETRY

Fukugita, T.Y. (1986)

BARYON ASYMMETRY :

$$\frac{n_B}{s} \simeq -0.35 \, \frac{n_L}{s}$$

chemical equilibrium conditions

$\rightarrow \left\{ \Delta B = \frac{8N_f + 4N_H}{22N_f + 13N_H} \, \Delta(B-L) \right\}$

$$\frac{n_L}{s} \simeq \kappa \left(\frac{1}{g_*} \right) \varepsilon$$

degrees of freedom

Dynamical factor from out-of-equilibrium condition

$$\frac{n_B}{s} \simeq \kappa \times 10^{-3} \, \varepsilon$$

* ESTIMATION OF ε : ASSUMING $M_3 > M_2 > M_1$

CONSIDER N_1 DECAY :

Flanz, Paschos, Sarkar
Covi, Roulet, Vissani
Buchmuller, Plumacher
Pilaftsis. (1996)
⋮

$$\varepsilon_{(1)} \equiv \frac{\Gamma(N_1 \to L + H) - \Gamma(N_1 \to \bar{L} + \bar{H})}{\Gamma(N_1 \to L + H) + \Gamma(N_1 \to \bar{L} + \bar{H})}$$

$$\simeq \frac{3}{16\pi} (\sin \delta) \, \frac{m_{\nu_3} M_1}{\langle H \rangle^2}$$

$$\simeq (\sin \delta) \times 10^{-6} \left\{ \frac{M_1}{10^{10}\,\mathrm{GeV}} \right\}$$

FOR $m_{\nu_3} \simeq 0.05\,\mathrm{eV}$, $\langle H \rangle \simeq 170\,\mathrm{GeV}$.

CP PHASE

$$\frac{n_B}{s} \simeq \kappa \,(\sin\delta)\; 10^{-9} \left(\frac{M_1}{10^{10}\,\mathrm{GeV}}\right)$$

κ SHOULD BE DETERMINED BY SOLVING THE Boltzmann EQUATIONS :

$$\kappa = f\,(h_{i1},\, M_1).$$

$$\kappa \lesssim 0.1 - 1 \quad ; \quad |\sin\delta| \leq 1$$

$M_1 \gtrsim 10^9$ GeV TO EXPLAIN THE OBSERVATION :

$$\frac{n_B}{s} \simeq (0.4-1)\times 10^{-10}.$$

ON THE OTHER HAND, $T_R \lesssim 10^{10}$ GeV TO AVOID THE OVERPRODUCTION OF GRAVITINOS. Weinberg (1980)

Khlopov, Linde

Ellis, Kim, Nanopoulos

Kawasaki, Moroi

⋮

$$M_1 \lesssim T_R$$

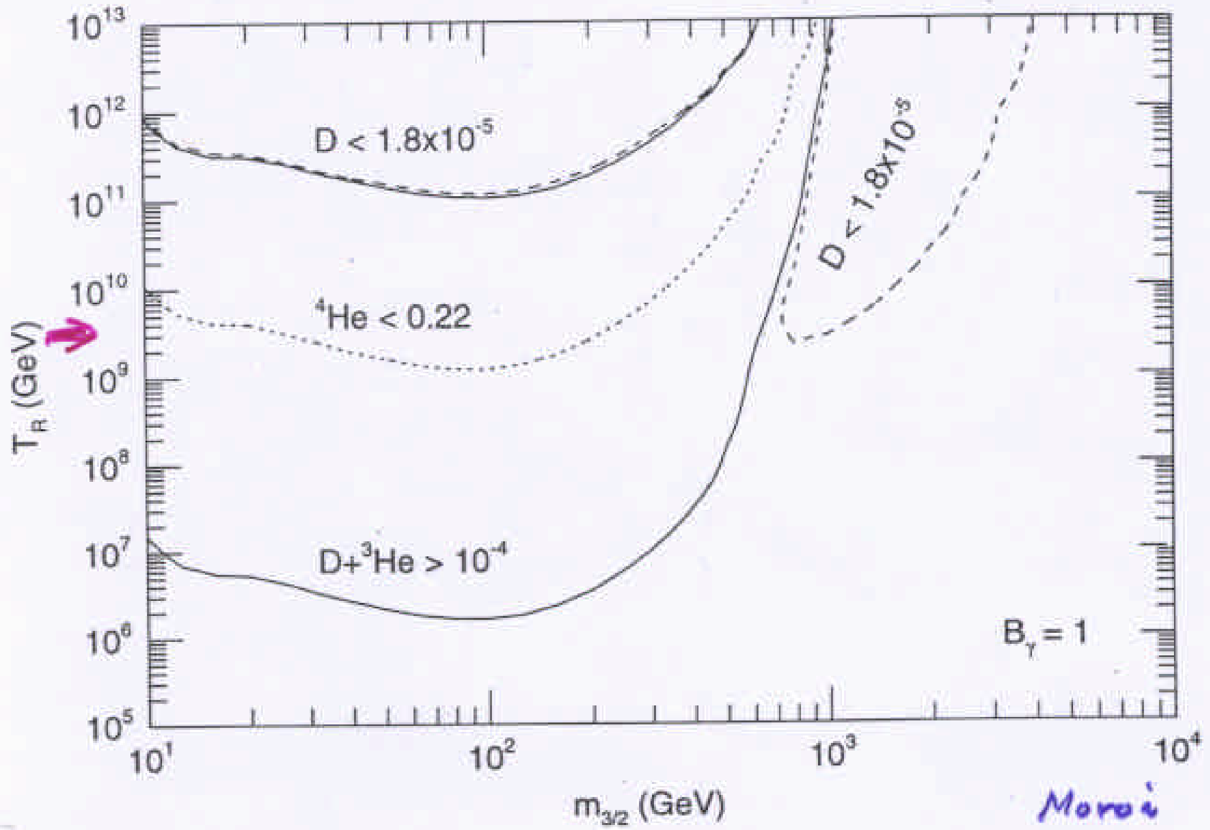
$$\begin{cases} M_1 \simeq 10^9 - 10^{10}\ \mathrm{GeV} \\ m_\nu \simeq 10^{-3} - 10^{-2}\ \mathrm{eV} \end{cases}$$

SEE Fig.

$$\text{c.f.} \begin{cases} m_{\nu_3} \simeq 0.05\,\mathrm{eV} \\ m_{\nu_2} \simeq 0.005\,\mathrm{eV} \end{cases}$$

SEESAW : $m_\nu \simeq m_D^2/M$: $m_{\nu_3} \simeq 0.05\,\mathrm{eV},\ m_D \simeq m_t \rightarrow M_3 \simeq 10^{15}\,\mathrm{GeV}$

IF $M_3 : M_2 : M_1 \simeq m_t : m_c : m_u$; $M_1 \simeq 10^{10}$ GeV !!



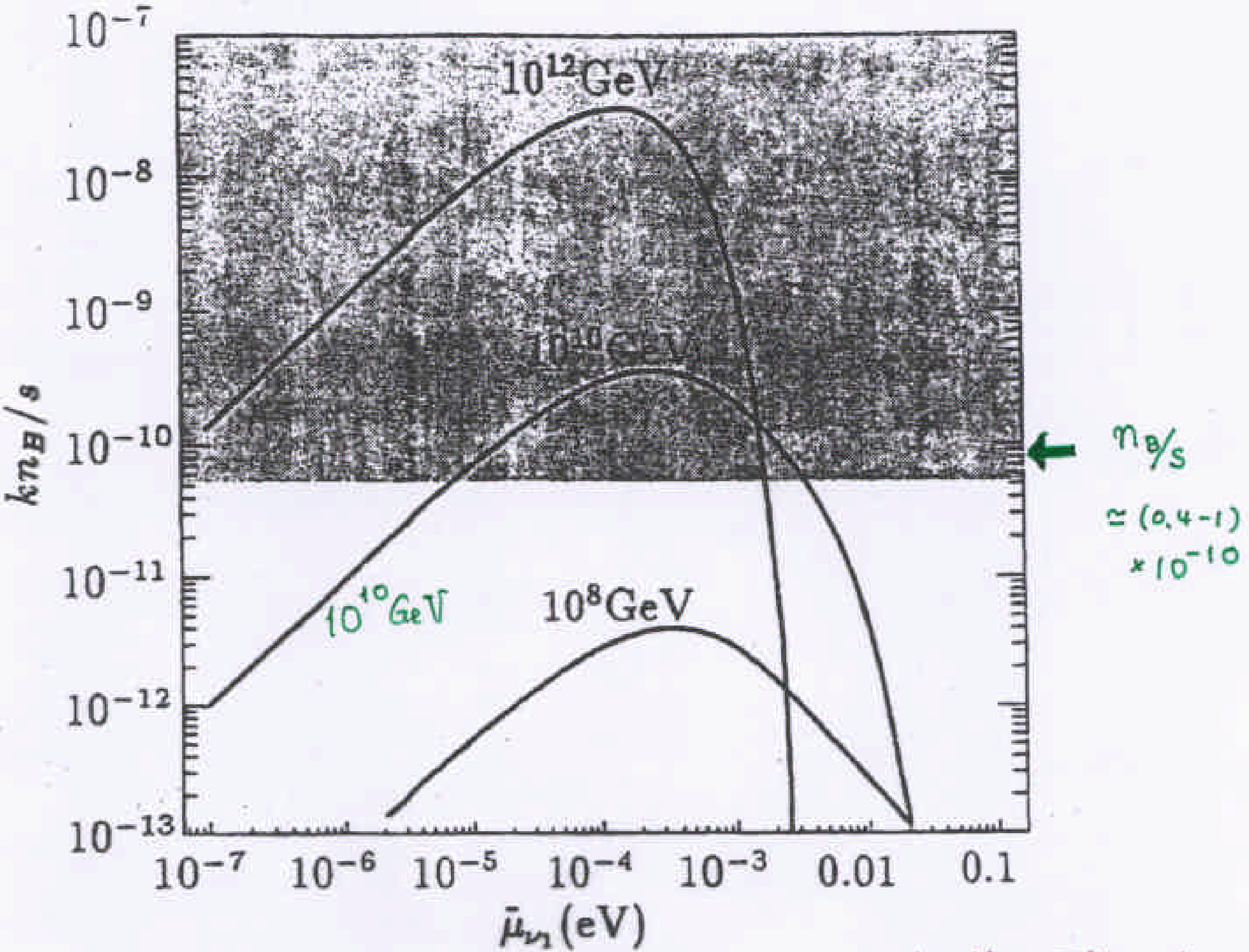
ɡure 6.6: Upperbound on T_R as a function of $m_{3/2}$. Here, we take $B_\gamma = 1$. In the region ove the solid curve ^{3}He and D are overproduced, the abundance of ^{4}He is less than 0.22 ove the dotted curve and the abundance of D is less than 1.8×10^{-5} above the dashed rve.

$$T_R \lesssim 10^{9-10} \text{ GeV}$$

FOR $m_{3/2} \simeq O(1)$ TeV.

Fig.4

$n_B/S \simeq (0.4 - 1) \times 10^{-10}$



Buchmuller, Plümacher

$M_1 \simeq 10^9 - 10^{10}$ GeV

$T_{leptogenesis} \simeq 10^{10}$ GeV

Fig. 5

TEMPERATURE FOR LEPTOGENESIS

$$T_{L.G.} \simeq 10^{10}\ \mathrm{GeV}.$$

Buchmuller, Plumacher

$\Downarrow$

$$m_{3/2} < 1\ \mathrm{keV} \quad \text{OR} \quad m_{3/2} \gtrsim 1\ \mathrm{TeV}$$

($m_{3/2} \sim (30-50)\ \mathrm{GeV}$

GRAVITINO DARK MATTER

Buchmuller)

☆ THE BARYON ASYMMETRY CAN BE NATURALLY EXPLAINED BY OBSERVED NEUTRINO MASSES !!

m_ν SHOULD NOT BE TOO LARGE ($m_\nu > 0.1\ \mathrm{eV}$)

AND SHOULD NOT BE TOO SMALL ($m_{\nu_3} < 10^{-3}\ \mathrm{eV}$).

SEE Fig.

☆ IF $M_1 \simeq M_2$,  DOMINATES. $M_1 - M_2 > \Gamma_N$

$$\varepsilon_{(1)} \simeq \mathrm{Im}(hh^\dagger)^2_{12} \times \frac{1}{M_1 - M_2}$$

$$\varepsilon_{(2)} \simeq \mathrm{Im}(hh^\dagger)^2_{21} \times \frac{1}{M_2 - M_1}$$

$$\varepsilon_{(1)} + \varepsilon_{(2)} \simeq 2 \times \varepsilon_{(i)}$$

ε IS ENHANCED WHEN $M_1 \sim M_2$!! Flanz, Paschos, Sarkar, Pilaftsis

$$\begin{cases} M_1 \sim M_2 \sim 10^8\ \mathrm{GeV} \\ T_R \sim 10^8\ \mathrm{GeV} \end{cases}$$

Ellis, Raidal, T.Y.

$m_{3/2} \gtrsim$ a few $\times$ 100 GeV

III. LEPTOGENESIS FROM $\tilde{N}$-DOMINATED EARLY UNIVERSE

$$\frac{h^2}{M_N} \simeq \frac{1}{10^{15}\,\mathrm{GeV}}$$

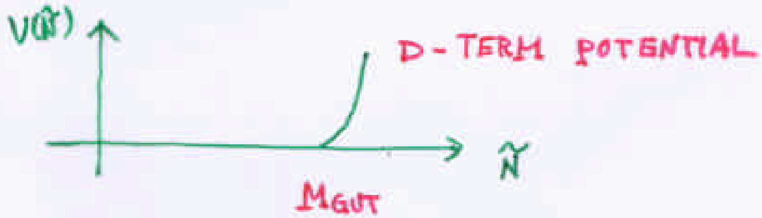
FOR $h \ll 1$, $M_N \ll 10^{15}\,\mathrm{GeV}$.

IF $M_N < H_{inf}$, SCALAR N, $\tilde{N}$, MAY HAVE LARGE CLASSICAL VALUE AND IT DOMINATES THE UNIVERSE IF THE LIFE TIME IS SUFFICIENTLY LONG.

Murayama, T.Y (1994)

BUT, WHY $h \ll 1$, AND $M_N \ll M_{GUT}$?

WHY $\tilde{N}_0 \sim M_{Planck}$?



$\tilde{N}_0 \sim M_{GUT}$ IS NATURAL.

THESE TWO SERIOUS PROBLEMS HAVE BEEN SOLVED.

Hebecker, March-Russell, T.Y.

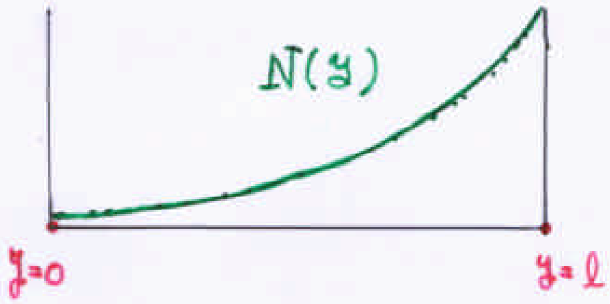
FIVE DIMENSIONAL SPACETIME WITH S^1/Z_2 ORBIFOLD.

Hebecker, March-Russell

INTRODUCE 3 PAIRS OF N AND $\bar{N}$ IN THE BULK, WHICH HAVE MASSES OF ORDER THE FUNDAMENTAL SCALE M_*.

$$-M \cdot \bar{N} \cdot N \qquad\qquad M \sim M_*$$

$$Z_2 : \begin{cases} N \to N \\ \bar{N} \to -\bar{N} \\ M \to -M \end{cases}$$



$$N(y) = e^{-M(\ell-y)}$$

CONSIDER (B-L) BREAKING AT $y=0$ FIXED POINT :

$$\langle \Phi_{B-L} \rangle = M_* \delta(y), \to \quad M_* NN \delta(y).$$

WHICH LEADS TO 4-DIM. MASSES FOR N's :

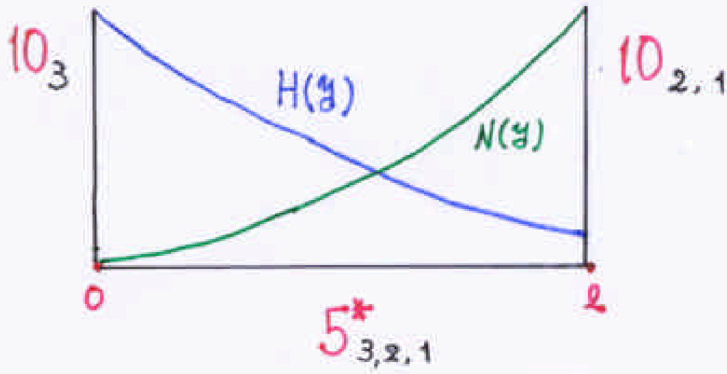
$$M_R \simeq M_* e^{-2M\ell}.$$

FOR $M_* \ell \simeq 12$, $M_* \simeq 7 \times 10^{17}$ GeV $\quad (\because M_*^2 (M_* \ell) \simeq M_{Planck}^2)$.

THEN, ONE GETS $M_R \simeq 10^7$ GeV.

$$\tilde{N}_0 \simeq M_* \sim 10^{18} \text{ GeV}.$$

Yukawa COUPLING $h\, N \cdot 5^* H$:



VARIANT H-M-R MODEL

Higgs H AND $\bar{H}'$ HAVE A BULK MASS $\sim M_H H \cdot \bar{H}'$.

$$m_c/m_t \simeq e^{-M_H \ell} \simeq 1/400$$

$$M_H \ell \simeq 6$$

$$h N 5^* H : \quad h \sim \frac{h_0}{\sqrt{M_* \ell}}\, e^{-M_H \ell} \sqrt{\frac{M_H}{M_*}} \sim 10^{-4}$$

FOR $h_0 \sim 0.2$
($m_b/m_t \simeq 0.02$
$\tan\beta \simeq 3$)

$$m_\nu \sim \frac{h^2 \langle H \rangle^2}{M_R} \simeq 0.01 \text{ eV} \;!!$$

WE HAVE SMALL Yukawa COUPLINGS h_{ij}, NATURALLY :

$$h \simeq 10^{-5} - 10^{-4}.$$

HISTORY OF UNIVERSE WITH N_1,

WHOSE MASS $\sim 10^9$ GeV AND Yukawa COUPLING $\sim 10^{-5}$.

Hamaguchi, Murayama, T. Y.

★ DURING INFLATION $\tilde{N}_1$ HAS A LARGE CLASSICAL VALUE, $\tilde{N}_0 \simeq 10^{18}$ GeV, AS $H_{inf} \gg m_N$.

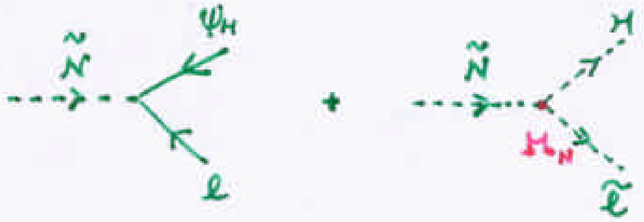
AFTER THE INFLATION ENDS, H DECREASES AND WHEN $H \simeq m_N$, $\tilde{N}$ STARTS OSCILLATING. THE $\tilde{N}$ OSCILLATION DOMINATES THE EARLY UNIVERSE AS LONG AS $\tilde{N}$ LIVES MUCH LONGER THAN THE INFLATON χ : $\Gamma_N \ll \Gamma_\chi$.

$\{|h| \ll 1\}$

- ONCE $\tilde{N}$ DOMINATES THE UNIVERCE MOST OF THE IMPORTANT INPUTS OF THE UNIVERSE ARE DETERMINED BY NATURE OF $\tilde{N}$.
- $\tilde{N}$ DECAY GIVES LEPTON ASYMMETRY (B ASYMMETRY) AND ENTROPY (T_R).
- $\frac{\delta \rho_{\tilde{N}}}{\rho_{\tilde{N}}}$ BECOMES THE ADIABATIC FLUCTUATION $\frac{\delta \rho}{\rho}$.

Lyth, Wands
Moroi, Takahashi

LEPTON ASYMMETRY FROM $\tilde{N}_1$ DECAY:



$$\varepsilon_{(1)} \simeq 1 \times 10^{-10}\, \delta_{eff} \left(\frac{M_N}{10^6\,\mathrm{GeV}}\right)\left(\frac{m_{\nu_3}}{0.05\,\mathrm{eV}}\right)$$

$\tilde{N}$ DECAY PRODUCES THE RADIATIONS AND THE ENTROPY DENSITY IS GIVEN BY

$$S = \frac{2\pi^2}{45} g_* \, T_N^3 \, .$$

T_{N_1} IS DETERMINED BY THE DECAY RATE Γ_N AS

$$\frac{\pi^2}{30} g_* \, T_N^4 \simeq M_N^2 \, |\tilde{N}_D|^2$$
$$\simeq 3 \, M_{Pl}^2 \, \Gamma_N^2$$

$$\frac{n_L}{s} \simeq \frac{3}{4}\, \varepsilon_{(1)} \left(\frac{T_N}{M_N}\right)$$
$$\simeq 0.7 \times 10^{-10} \left(\frac{T_N}{10^6\,\mathrm{GeV}}\right)\left(\frac{m_{\nu_3}}{0.05\,\mathrm{eV}}\right) \delta_{eff} \, .$$

$$\frac{n_B}{s} \simeq 0.35 \times \frac{n_L}{s} \simeq 0.3 \times 10^{-10}$$

FOR $T_N \simeq 10^6\,\mathrm{GeV}$, $\delta_{eff} \simeq 1$

O.B.S. $\frac{n_B}{s} \simeq (0.4 - 1) \times 10^{-10}$

$$\Gamma_N \simeq \frac{h^2}{8\pi} M_N$$

$$T_N \simeq 0.1 \cdot h \sqrt{M_{Pl} M_N} \simeq 3\times 10^6 \,\mathrm{GeV}$$

FOR $M_N \sim 10^7\,\mathrm{GeV}$

$h \sim 10^{-5}$

✡ NO GRAVITINO PROBLEM.

GRAVITINOS PRODUCED AT THE REHEATING EPOCH AFTER INFLATION ARE DILUTED BY THE ENTROPY PRODUCTION IN $\tilde{N}$ DECAY.

$$T_{eff} \simeq T_N \sim 10^6 \,\mathrm{GeV}$$

FOR $T_R \lesssim 10^{12}\,\mathrm{GeV}$.

A WIDE RANGE OF $m_{3/2}$ IS CONSISTENT WITH THE PRESENT SCENARIO :

$$m_{3/2} \gtrsim \underline{10}\,\mathrm{MeV}$$

OR $m_{3/2} < 1\,\mathrm{keV}$.

* GAUGE-MEDIATION MODEL WITH $m_{3/2} \simeq 10\,\mathrm{MeV} - 1\,\mathrm{GeV}$ IS CONSISTENT.

✱ SCALE-INVARIANT DENSITY FLUCTUATIONS :

THE OBSERVED CMB POWER SPECTRUM SUGGESTS ALMOST SCALE-INVARIANT DENSITY FLUCTUATIONS :

$$\frac{\delta\rho}{\rho} = \text{SCALE-INVARIANT.}$$

THE DENSITY FLUCTUATIONS ARE PRODUCED DURING INFLATION. THE SIMPLEST POSSIBILITY IS THAT THEY ARE ORIGINATED FROM FLUCTUATIONS OF THE INFLATON FIELD.

$$\frac{\delta\rho}{\rho} \simeq x \left[\frac{H^3_{inf}}{V'_{inf}} \right] \qquad : V' = \frac{\partial V}{\partial x}$$

IN MANY INFLATION MODELS, THE EXPANSION RATE H_{inf} IS ALMOST CONSTANT DURING THE INFLATION. BUT, THE SLOPE V'_{inf} CAN VARY.

HOWEVER, IF $\tilde{N}$ DOMINATES THE EARLY UNIVERSE, $\delta\rho/\rho$ IS DETERMINED BY THE FLUCTUATIONS OF $\tilde{N}$.

$$\left.\frac{\delta\rho}{\rho}\right|_{\tilde{N}} \simeq \frac{H_{inf}}{2\pi} \simeq \text{ALMOST CONSTANT.}$$

MAY SOLVE A PROBLEM IN THE EKPYROTIC SCENARIO IN THE BRANE WORLD.

Lyth.
MOROI AT SUSY

CONCLUSION :

- THE SEESAW MODEL OF GRSY EXPLAINS VERY NATURALLY

  NOT ONLY THE SMALL NEUTRINO MASS

  BUT ALSO THE UNIVERSE'S BARYON ASYMMETRY

$$\frac{n_B}{s} \simeq (0.4-1) \times 10^{-10}.$$

EXPERIMENTAL OBSERVATIONS ON

$0\nu 2\beta$ DECAY

AND

$\not{CP}$ IN ν OSCILLATION

ARE REQUIRED TO CONVINCE OURSELVES OF

THIS SCENARIO.

- $\tilde{N}$ - DOMINATED UNIVERSE MAY PROVIDE A NEW SCENARIO OF INFLATIONAL UNIVERSE.